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THE UNITED STATES ENTOMOLOGICAL COMMISSION.

Fifth Report of the United States Entomological Commission on Insects Injurious to Forest and Shade Trees. By Alpheus S. Packard, M.D., Ph.D.

VERY valuable Reports have been presented by the United States Entomological Commission from time to time. Among these may be mentioned that upon "The Rocky Mountain Locust," prepared by Prof. Riley in 1878, which is a most exhaustive record of the habits of this terrible pest, and of methods of prevention and remedies against its attacks. Later on, an equally valuable and instructive Report was submitted with regard to the cotton worm (*Aletia argillacea*), very destructive to the cotton plant, whose crop it has reduced in some seasons from 30 to 75 per cent. in the principal cotton-producing States. Both these elaborate works, as might be expected from their authors, Prof. Riley and Dr. Packard, who practically constituted this Entomological Commission, are full of interesting experiments, ingenious contrivances, and subtle devices, to circumvent the insect hordes advancing with the insistance of invading armies.

This Report upon "Insects Injurious to Forest and Shade Trees" is perhaps not so exciting or painfully interesting, as the harm caused to trees is not so directly felt as that occasioned to various food crops and other crops of the field by locusts and caterpillars innumerable, and the name of the insects described therein is legion, and their individual mischief is comparatively small.

As Dr. Packard says, "a volume could be written on the insects living on any single kind of tree, and hereafter it may be expected that the insect population of the oak, elm, poplar, pine, and other trees will be treated of monographically." Kaltenbach, in "Die Pflanzenfeinde, aus der Klasse der Insekten," gives accounts of 537 European species of insects injurious to the oak, 107 to the elm, and 396 to the willow. Perris, a French observer, has recorded no less than 100 species of insects found upon the maritime pine.

The attacks of insects upon forest trees and upon shade trees, or trees planted for shade and ornamentation in parks, streets, and other public places, are becoming far more numerous and serious, just as in the case of all cultivated crops under the sun. In the United States these attacks are creating intense interest, as the forests are of the highest commercial importance, and have been extensively decreased by clearing, by wanton and accidental fires, and other causes. This Report, then, is opportune, and must be of great service, as it demonstrates the sources of the injuries, and suggests means of preventing them or of diminishing them.

The French, German, Austrian, and Italian Departments of Agriculture are giving much attention to this subject, for it is found that the forest trees of these countries are becoming more liable to harm from insects. In Great Britain some kinds of trees, notably of the pine tribe, have suffered much damage from insects hitherto unknown, or, at least, not reckoned as injurious. There are, without doubt, many others unsuspected in British woods and forests, slowly but surely working great mischief.

Dr. Packard shows that trees are attacked in every part and in every conceivable manner by insects. Their roots, leaves, bark, fruit, and twigs are all more or less subject to their visitations. The most curious of those which affect the roots is the "seventeen year" Cicada, whose larvæ remain for over sixteen years attached to the rootlets of the oak, other forest trees, and fruit trees, as the pear and apple. According to Prof. Riley, these larvæ are found at a great depth, sometimes as much as 10 feet below the surface. The female, resembling a locust, deposits long slender eggs in an unbroken line upon the terminal twigs of oak and other trees in May and June. Sometimes the twigs are so "badly stung" by this oviposition that the trees are seriously injured. The length of wood perforated on each branch sometimes varies from one to two and a half feet, averaging probably eighteen inches, and appearing to be the work of one female. From the eggs the larvæ hatch out in six weeks and drop to the ground, in which they live, sucking the roots of the trees for nearly seventeen years, the pupa state lasting but a few days.

A formidable enemy of the "live-oak" (*Quercus virens*) is an enormous beetle, *Mallodon melanopus*, Linn., whose larva, three inches long and an inch in thickness, bores into the roots upon which it lives. As a result of the work of this insect in South Georgia and Florida, "vast tracts, which might otherwise have become forests, enriching the ground with annual deposits of leaves, are reduced to comparatively barren scrub, in which the scattered oak-bushes barely suffice to cover the surface of the sand." The eggs are laid by the beetle in the foot, or collar, of the tree, just below the surface of the ground. It is not known how long the larvæ live, but their life must extend over several years, "since the roots occupied by them grow to a large size, while they show an abnormal development, and become a tangle of vegetable knots. In fact, the entire root in its growth accommodates itself to the requirements of the borer within." The effect on the tree is to kill the original stem, which becomes replaced by a cluster of insignificant and straggling suckers, forming, perhaps, a clump of brushwood.

Among the tree-borers, other than beetles, the oak "carpenter worm," the caterpillar of *Prionoxystus robiniæ*, Peck, is the largest and most destructive. It is larger and far more abundant than the European caterpillar of *Cossus ligniperda*, or goat-moth, belonging to the same family of Cossidæ, but it sinks its tunnels deep in towards the heart of the tree, not confining its mischief to the limbs and large branches like the goat-moth caterpillar. Fitch says of this:—"Of all the wood-boring insects in our land, this is by far the most pernicious, wounding the trees most cruelly. The stateliest oaks in our forests are ruined, probably in every instance where one of these borers obtains a lodgment in their trunks." Another species of Cossus, known as *Cossus centerensis*, bores into poplars. Its appearance and habits also resemble those of the goat-moth, well known in this country.

There are numbers of boring beetles, of the families Buprestidæ, Cerambycidæ, and Scolytidæ, whose larvæ make burrows, passages, and galleries in trees, mainly just under the bark. Of these, the elm-tree borer, *Saperda tridentata*, is prominent, often killing elm-trees by wholesale, both in forests and in public parks. The larvæ bore in the inner bark, making irregular furrows and tunnels upon the surface of the wood, which "is, as it were, tattooed with sinuous grooves, and the tree completely girdled by them in some places." In the State of Illinois attention was attracted to the gradual decay and death of white elms (*Ulmus americanus*) in rows in some towns. The leaves fell off in the summer, and some of the branches died. Finally, the tree perished altogether. On peeling off the bark, half-grown larvæ of *Saperda tridentata* appeared in considerable numbers, and the manner in which the bark had been mined by the Saperdas gave sufficient evidence of the cause of the death of the tree. Prof. Forbes, State Entomologist of Illinois, says: "From the present appearance of the elms throughout the towns of Central Illinois, it seems extremely likely that this pest will totally exterminate this tree, unless it be promptly arrested by general action." It is recommended that all affected trees should be removed and destroyed in autumn and winter, before the beetles have a chance to emerge from the trunks. This beetle is not quite an inch long; its larva is rather more than an inch in length, having a large flat head.

Fir trees, especially the white pine (*Pinus strobus*), the yellow pine (*Pinus mitis*), and *Pinus rigida*, are much injured by the pine borer or "sawyer," *Monohammus confusor*. "I have seen," writes Dr. Packard, "hundreds, perhaps nearly a thousand, dead firs, whose trunks were riddled with the holes of these borers." Dr. Packard cites a correspondent of the *North-Western Lumberman* who reported that "extensive and valuable forests of yellow pine in the Southern States are destroyed by a worm commonly called here a 'sawyer,' or flat head." White pine trees are also much beset by the "wood engraver" bark beetle (*Xyleborus xylographus*, Fitch), so called because it makes beautifully regular and artistic furrows on the surface of the wood under the bark. It is the most common, and probably the most pernicious, of all the insects that infest the forests of white pine in New York State, and of yellow pine in the States south of New York.

A weevil, the white pine weevil (*Pissodes strobi*), frequently spoils the finest white pines in parts of America by placing numerous eggs in the bark of the topmost shoots of fir trees; the larvæ from these make mines in the wood and pith, causing the shoots to wither and die, thereby occasioning a fork, or crook, at this point. This is a very small insect, not three-quarters of an inch long, and the larvæ are not half an inch in length.

There is a mighty army of caterpillars of various moths described in this Report, which devour the foliage of trees of all kinds in American forests and gardens. Several species of Clisiocampa and Gasteropacha, of the Bombycidæ, assail oak, willows, ash, chestnut, apple, and pear trees. These are termed "tent" caterpillars, as they live in webs of a tent-like form, as the *Clisiocampa Neustria*, or lackey moth, in Europe. But the most voracious of caterpillars are the "fall web worms" of the moth *Hyphantria cunea*, Drury. For instance, in 1886, the city of Washington, as well as its vicinity, was entirely overrun by them. All vegetation, except that not agreeable to their tastes, suffered greatly. Fine rows of shade trees, which grace the streets and avenues, were leafless in midsummer, and covered with hairy worms. The pavements were strewn with moultings of the caterpillars and their webs, which were blown about unpleasantly by the wind.

Because they are hairy they have comparatively few enemies, among birds at all events. The "English sparrow," fast becoming as great a nuisance in the United States as the rabbit in Australasia, will not look at them, and has driven away by its pugnacity many birds that would eat them. Fortunately there are insect enemies which prey upon them, as the *Mantis carolina*, or "rear horse," an extraordinary insect of the same family as the "praying" mantis, and the "wheel bug" (*Prionidus cristatus*). Several parasitic insects also greatly check the spread of this moth. One fly, *Telenomus bifidus*, Riley, lays its egg within the tiny egg of the moth, in which all the transformations of the fly take place, and its food and lodging are found. In due time, having cleared out the egg, the fly emerges.

Mr. Bates, in his graphic account of tropical insects, has pictured many that are made to closely resemble their surroundings, for their preservation and other purposes. In his well-known paper on mimicry, he alludes to the insects known as Phasmidæ, or "spectre" insects, as especially typical of this adaptation to circumstances, preserved and augmented, as Darwin says, "through ordinary selection for the sake of protection." Mr. Wallace brings forward the Phasmidæ as striking instances of mimicry, remarking that "it is often the females alone that so strikingly resemble leaves, while the males show only a rude approximation."

Species of this family of Phasmidæ are mischievous to trees in America, principally the oak and the hickory. The chief of these is the *Diapheromera femorata*, Say., popularly called "walking-stick," "walking-leaves," "stick-bug," "spectre," "prairie alligator," "devil's horse." This insect, especially the female, is so like the twigs of trees in colour and appearance, that it is difficult to discover it. It has a habit, too, of stretching out the front legs and feelers, greatly enhancing this resemblance. While the vegetation is green the "walking-sticks" are green; when the foliage changes in the autumn they also change colour; and when the trees are bare of leaves they closely resemble the twigs on which they rest. The eggs are dropped upon the ground from whatever height the females may be, "and, during the latter part of autumn, where the insects are common, one hears a constant pattering, not unlike drops of rain, that results from the abundant dropping of these eggs, which in places lie so thick among and under the dead leaves that they may be scraped up in great quantities." Prof. Riley adds, with regard to these singular creatures and their wonderful resemblance to the oak vegetation upon which they occur, "one cannot help noticing still further resemblances. They are born with the bursting of the buds in the spring; they drop their eggs as the trees drop their seeds, and they commence to fall and perish with the leaves, the later ones persisting, like the last leaves, till the frost cuts them off."

There is not space enough to do more than allude to the sawflies, another class of insects fearfully injurious to trees of divers kinds. Many of these Hymenoptera, as in Great Britain and other European countries, mainly of the genus *Nematus*, clear off the leaves of forest and fruit trees. Others attack firs, notably some species of Lophyrus and Lyda, as the *Lophyrus abietis*, *Lophyrus pinetum*, and *Lophyrus pini-rigidæ*, and some of the Lyda. Cameron, in his monograph of the British phytophagous Hymenoptera, states that there are fifteen species of Lophyrus in North America, and that the species of Lyda are common there.

Lophyrus abietis and *Lophyrus abbotii* appear to do the same harm in America to firs as the *Lophyrus pini* in Scottish fir plantations, whose larvæ not only eat the leaves but the bark of the young shoots, frequently occasioning great losses.

An instructive account is given in this work of the effect of temperature upon insects. It is the fashion in Great Britain to say that insects are killed by hard frosts. But they are not killed in countries—as America, for example—whose winters are far more severe. Dr. Packard, quoting Judeich and Naitsche's "Lehrbuch der Mittel-Europäischen Forstinsektenkunde," observes that "the influence of even very great cold on the normal hybernating stages of our insects is not very great. In the summer of 1854 the 'nun' moth had very generally laid its eggs in Eastern Prussia uncovered on the bark, and these did not freeze in the hard winter of 1854–55. According to the observations of Regener, openly exposed caterpillars of the pine silk-worm endured 10° F. The pupa froze at 21° F., the moth at 19° F. According to Duclaux, the eggs of the silk-worm endure well, remaining two months in a temperature of 17° F. Great fluctuations of temperature during the winter produce an abnormal interruption of the winter's rest or hibernation, and thus cause the death of many insects." It will be noticed that in all these cases the insects were unprotected, whereas there is generally some kind of protection during the winter for insects in all stages, provided by their instinct.

Not the least useful part of the Report is that treating of remedies for insect attacks, and machines and engines for applying them. Arsenical poisons, known as Paris Green and London Purple, are strongly recommended for spraying or syringing trees infested with the larvæ of beetles and sawflies, or the caterpillars of moths. These have been recently introduced into England, being advocated by the Board of Agriculture, but have not been extensively adopted yet, owing to the natural prejudice against the use of poisons. In America they are employed most extensively and with the greatest benefit. By means of these the potato beetle (*Doryphora decemlineata*) was circumvented, and the cotton and boll worms checked, and the onslaughts of many other insects materially lessened. For Aphides, Scale insects, and other insects which suck the sap of leaves, "emulsions" or washes of soft soap, or "jelly soaps," made directly from fish oil and concentrated lye, or whale-oil soap, are prescribed. Also kerosine, naphtha, and petroleum, applied in a fine spray, or mixed with soap and soap jelly, forming "emulsions." These remedies act by contact, being applied principally to insects which do not eat the leaves, as well as by making the surroundings unpleasant and unbearable. Powdered substances, as pyrethrum, hellebore, and sulphur, are not much employed for forest work, but cases frequently arise warranting their use in a limited way. Hellebore, as gooseberry growers in Kent and Cambridgeshire well know, is of especial value against all sawfly larvæ. Sulphur is valuable against the red spider (*Tetranychus telarius*), and is used alone or in connection with emulsions of kerosene.

Numerous machines are in vogue for putting on washes and powders, from the small "knapsack" machine carried on the back, to huge tanks on wheels, fitted with powerful hand-pumps and long lengths of hose, through which liquids are forced to great heights; for very high trees, tall ladders are used, which are set near the trees, upon which men mount, and direct the hose into the topmost branches. For smaller trees and shrubs, a barrel fixed on wheels, having a good force-pump with hose, is adopted. Pumps are also fitted into tanks of all shapes and sizes, and moved from place to place by hand or horse-power. To distribute the liquids there are endless nozzles or jets contrived with much ingenuity to send forth fine mists, or sprays, or continuous volumes. It will suffice to say that the best of these is the cyclone, or Riley nozzle, which is just being introduced into Great Britain.

Foresters, and all concerned in the management of woods and forests, public parks, and gardens, would do well to consult this work for information as to the various insect enemies of trees, and the best means of dealing with them. It is quite impossible in a review to give anything more than a general idea of its scope and nature.

PHYSICAL RELIGION.

Physical Religion. The Gifford Lectures delivered before the University of Glasgow in 1890. By F. Max Müller. (London: Longmans, 1891.)

THE present volume, which embodies the author's second course of Gifford Lectures, with notes and appendices, is devoted to the consideration of "Physical Religion," that is the religion which finds its object the Infinite in or behind the phenomena of Nature. The author's previous writings have made it clear that for the simplest and most abundant manifestation of this form of religion we must go to the Veda, so his first task in the lectures before us is to tell once more the familiar story of the discovery, the character, and the age of the Veda. To this survey four lectures are devoted, and, in conclusion, the author—not without duly considering all that in recent years has been urged to the contrary—reaffirms his conviction that the hymns of the Rig Veda cannot have been collected later than 1000 B.C.

In the sixth lecture the author deals with the evolution of the idea of God. It is often supposed—even by philosophers of repute—to be a sufficient account of the earliest form of religion to say that men worshipped stones and other fetishes as their gods. But, as the professor well remarks—

> "Does it never strike these theorizers that the whole secret of the origin of religion lies in that predicate, *their gods?* Where did the human mind find that concept and that name? That is the problem which has to be solved; everything else is mere child's play."